# STOP-SAND LINER HANGER ASSEMBLY FOR WATER WELLS

The present invention refers to the installation of gravel packing in water wells. More particularly, this invention relates to the emplacement of gravel through a Stop-Sand Liner Hanger (SSLH) containing a simple sealing mechanism actuated by the setting of the said Stop-Sand Liner Hanger in a cemented casing, gravel ports being opened when a gravel setting tool is installed through which gravel and water are pumped down into the formation (aquifer) – screens/liners annulus.

The efficiency of commercial (standard) Liner Hanger Packers used in water wells for installation of gravel packs has been often unsatisfactory due to the difficulty of a proper installation leading, in extreme cases, to the loss of the well itself. The often complicated internal system to open and close gravel ports and the defective annulus sealing by rubber packers are the predominant causes for such poor efficiency. Moreover, such systems usually require the intervention of qualified engineers for their installation.

Gravel packing completion for water wells can become time consuming as it is never achieved in one run. In reality, the distribution of the gravel into the annulus can sometimes bridge off prematurely, leaving voids in the annulus. Usually, the gravel setting tool must be removed and put back in place one or more times before completing gravel packing, as the tools used to remove these voids require a free access to the screens.

Systems capable of completing multizone gravel packing in one trip, reducing rig time by eliminating the need to run extra tools between each pumping operation, are known from the prior art. However, these systems are expensive and usually aimed at oil production.

Furthermore, most of the prior art's systems require that the packers are removed from the well after completion of gravel packing leaving only a gravel screen assembly as described in US 4,733,723. A liner seal is then set for sealing engagement with the well bore for preventing migration of the gravel pack up the well annulus. This extra step, which is required by the configuration of these systems for the completion of the well, results in a loss of time.

US 4,662,446 discloses a device which does not require the removal of the gravel packers as it comprises an internal system which inflates, by fluid pressure, an elastomeric reversing boot. However, the complexity of such system implies a high production cost as well as the necessity of having highly qualified engineers for the installation and maintenance of such system.

The aim of this invention is, on the one hand, to allow an easy and trouble free installation which guarantees a stable and secure setting by eliminating the usual hold-down slips mechanism occurring with the conventional systems and, on the other hand, to reduce rig time involved with the often complicated settings and removals of the gravel setting tool while completing gravel packing.

This aim is achieved by a device such as set out in claim 1. Such device comprises a Stop-Sand Liner Hanger (SSLH) which is set inside the cemented casing by means of three elliptical balls fitted at 120 degrees from each other and at the same depth level on casing inner surface near the casing bottom. The SSLH comprises a gravel ports pipe, and a gravel setting tool guide pipe around which is fixed at the top end an upper external stop-ring, below said stop-ring are freely adjusted two rubber packers between an upper rubber packer protection ring and a push-up ring. The rubber packer is compressed as soon as the push-up ring rests on the three elliptical balls, said balls causing a relative upward movement of the push-up ring over the gravel setting tool guide pipe which tends to be dragged down by the weight of the SSLH and the underlying screens/liners. The rubber packer compression increases the packer

external diameter sealing off the annulus between the cemented casing and the SSLH.

The gravel ports pipe contains a simple mechanism actuated by simply lowering downwards a gravel setting tool which causes the opening of the Gravel Ports.

Unlike most of the systems used for gravel packing which tend to be relatively complex, the present invention does not need qualified engineers to install a gravel pack as the installation and removal of the said gravel setting tool is easy and trouble free.

The SSLH allows an unlimited and easy repetition of gravel emplacement operations until the gravel pack is homogeneous and complete. The removal of the gravel setting tool, after gravel packing completion, triggers the automatic closure of the gravel ports.

The invention will be better understood thanks to the following detailed description of a preferred embodiment with reference to the attached drawings, in which:

- Figure 1 represents, as an example, a schematic view of a completed water well with stop-sand liner hanger, gravel pack and a water pump.

- Figure 1a represents the installation of the SSLH by a liner hanger setting tool.

- Figure 1b represents a gravel packing completion operation using a gravel pack setting tool.

- Figure 1c represents a completed gravel packing.

- Figure 2 represents an exploded view of the SSLH comprising rubber packers and different rings set over the guide pipe and a gravel ports pipe.

- Figure 3 represents an elevated view of the SSLH which is about to rest on the three elliptical balls located on the internal surface of a cemented casing.

- Figure 3a represents an exploded view of the mechanism inside the gravel ports pipe.

- Figure 4 represents an elevated view of the Gravel Setting Tool.

Figure 1 shows a water well, after completion of gravel packing, ready for water production.

Figure 2 shows the constitutive elements of the mechanism which generates the expansion of rubber packers (6, 8) against the cylindrical cemented casing (1), thus sealing off the annulus (3) between the casing (1) and the SSLH (2) itself.

The mechanism comprises an upper external stop-ring (4) which is firmly kept in position by an overlying SSLH setting tool coupling (24) which is screwed on the upper threaded part (10) of the guide pipe (11), a first upper rubber packer protection ring (5), an upper rubber packer (6), an intermediate rubber packer protection ring (7), a lower rubber packer (8), and, finally, a push-up ring (9) at the bottom.

Three steel elliptical balls (13) are fitted with their supporting base into three casing slots (not shown) and then firmly welded on the inside and on the

outside of the casing before the casing (1) itself is installed and cemented. This balls-setting configuration and the balls rounded shape allow the run of a tricone rock bit or other tool.

The said upper, intermediate and lower (push-up ring) rings (5, 7, 9) have the same external diameter which is slightly bigger than the diameter of the upper and lower rubber packers (6, 8). While hanging the SSLH (2) on the three supporting elliptical balls (13), the push-up ring (9) slides (apparently) upwards over the guide pipe (11) as the latter is driven down by the weight of underlying screens/liners (15, 14). In actual fact is the upper external stop-ring (4) that, moving downwards solidly with the SSLH main body, squeezes the upper and lower rubber packers (6, 8) trapped between the upper packer protection ring (5) and the push-up ring (9).

The squeezing of the upper and lower rubber packers (6, 8) causes the said rubber packers to expand, sealing off the annulus (3) between the casing (1) and the SSLH (2). The diameters of the rubber packers (6, 8) have been determined as to have a small clearance between the internal casing diameter and the rubber packers (6, 8) to ensure optimum sealing when the rubber packers are expanded.

The SSLH (2) contains a gravel ports pipe (12) which comprises three ports (27), said pipe (12) is screwed to the bottom of the gravel setting tool guide pipe (11). As shown by Figure 3, the said gravel ports pipe (12) contains a spring case (17), a spring (18), a gravel ports piston lower ring (19), a gravel ports piston (20), and finally a gravel ports piston upper ring (21). The positioning of the gravel setting tool (23) inside the gravel ports piston (20) compresses the spring (18) causing the downwards movement of the ports (28) of same piston (20) to the same level as the ports (27) of said gravel ports pipe (12). The inner part of the gravel setting tool guide pipe (11) contains three guide plates (16) which are welded inside the pipe (11).

As shown by Figure 4, three wings (22), connected to the external diameter of the gravel setting tool (23) that contains three ports (31), slide between said guide plates (16) and guarantee that, when the gravel setting tool (23) is lowered, its ports (31) are correctly oriented to ensure perfect overlapping with the ports (28) of the piston (20). After completion of gravel packing, the gravel setting tool (23) is retrieved and the spring (18) causes the gravel ports piston (20) to regain its initial position closing the ports (27) of said gravel ports pipe (12).

A water well completion procedure using the device according to the invention can be broken down in three sequences.

1. Gravel Pack installation (Fig. 1a, 1b, 1c)
2. Development procedure
3. Pump installation for water production (Fig. 1)

Gravel packing is preceded by installing a SSLH (2) - Screen/Liners assembly (15, 14). This is achieved by means of a liner hanger setting tool (26) being fixed to the SSLH (2) by a rotational holding/release device.

The gravel setting tool (23) is then installed as aforementioned and the gravel packing process can start. Gravel and water are pumped through the workover string and the gravel ports (31). Gravel fills the screen annulus (3) and water returns to the surface by entering the screens (14) and through the lower and upper water ways (29, 30). Pressure gages are used to determine how the gravel packing progresses since the pressure inside the annulus (3) increases as the gravel packing level reaches the top of the screen (15). Pressure gages can also determine the presence of gravel bridges inside the gravel pack (25).

As mentioned earlier, gravel bridges from inside the gravel pack (25) must be removed in order to achieve a uniform and compact gravel packing. By retrieving only the gravel setting tool (23), it is possible to carry out all the necessary operations (mainly screen jetting and air lifting) to remove bridging. As a result of the simplicity of the gravel setting tool installation and removal, these operation may easily be repeated, if needed, until gravel packing is completed, reducing significantly the rig time.

In an alternate embodiment, the SSLH (2) has only one rubber packer, having adjacently to its both sides, a push-up ring (9) and a rubber packer protection ring (5).